



**US Army Corps
of Engineers**

Construction Engineering
Research Laboratory

CERL Technical Report 99/81
September 1999

Survey of Department of Defense Facilities with Low NOx Burners

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This study conducted a survey regarding recent experience with Low NOx Burners (LNBs) at Department of Defense facilities known to be operating or installing low nitrogen oxides-emitting burners on boilers. The data collected did not conclusively show that LNBs are chronically problematic, but a majority of the LNB-equipped boilers recorded in the data base reported problems with operation, installation, or commissioning. The most frequently reported problems were the failure of the units to reduce NOx emissions to the level promised and flame instability caused by a variety of factors.

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Executive Summary

Between October 1998 and February 1999, Technology & Management Services, Inc. conducted a survey for the U.S. Army Construction Engineering Research Laboratory (CERL) regarding recent experience with Low NO_x Burners (LNBs). The survey involved contacting 50 Department of Defense facilities operating or installing low nitrogen oxides-emitting burners on boilers and acquiring information on experience associated with the burners. Of the 28 facilities that responded to the questionnaire, only 13 reported operating LNBs and provided useful information. The data collected did not conclusively show that LNBs are chronically problematic, but a majority (10 of 16) of the LNB-equipped boilers recorded in the data base reported problems with operation, installation, or commissioning. The most frequently reported problems were the failure of the units to reduce NO_x emissions to the level promised and flame instability caused by a variety of factors. Numerous innovative solutions to these problems were reported in the survey, but overall, the LNBs seem to be a source of significant frustration.

Foreword

This study was conducted for U.S. Army Corps of Engineers (USACE) under Project 4A162784AT45, "Energy and Energy Conservation;" Work Unit UL-XC7, "Advanced Energy Supply Technology." The technical monitor was John Lanzarone, CEMP-ET.

The work was performed by the Energy Branch (CF-E), of the Facilities Division (CF), U.S. Army Construction Engineering Research Laboratory (CERL). Survey data was gathered by Technology & Management Services, Inc., Gaithersburg, MD, under contract DACA-98-D-0007. Peter Herz, George Powers, Douglas Uthus, and Steven Aylor are associated with Technology & Management Services, Inc. The CERL principal investigator was Michael K. Brewer. Larry M. Windingland is Chief, CECER-CF-E and Dr. L. Michael Golish is Chief, CECER-CF. The CERL technical editor was William J. Wolfe, Information Technology Laboratory.

The Director of CERL is Dr. Michael J. O'Connor.

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1 Introduction

Background

The U.S. Army Construction Engineering Research Laboratory (CERL) contracted with Technology & Management Services, Inc. (TMS) to conduct a survey of Department of Defense (DOD) facilities that have installed new burners to control emissions of nitrogen oxides (NO_x) on gas- and oil-fired boilers. The low NO_x burners (LNBs) are necessary to meet increasingly stringent air quality limits under the Clean Air Act Amendments of 1990 (CAAA). Operation with the LNBs, however, has raised concerns regarding the safety and performance of DOD industrial-sized boilers. Problems with flame control during LNB operation have been reported. There has also been a concern that manufacturers are not following the suggestions regarding LNBs contained in the non-binding appendix to the National Fire Protection Association (NFPA) Standard 8501, *Standard for Single Burner Operation*, 1997 Edition. These suggestions include relocating flame scanners and retesting operating margins after LNB retrofit.

Objectives

The objective of this study was to document installation, commissioning, and operational problems encountered with LNBs.

Approach

The method used to conduct the survey was outlined in the Research Plan TMS submitted to CERL on 30 October 1998. Facilities using LNB technology were identified. A questionnaire and data base were developed and tested on five initial facilities. The questionnaire was then sent to the rest of the facilities, and responses were collected. Data contained in the responses were then entered into the data base and analyzed.

Scope

This survey was sent to DOD military installations known to have recent experience with LNBs. Results of the survey, and conclusions drawn from the survey are intended to pertain to these applications.

Mode of Technology Transfer

This report and the raw survey data collected will be made available to aid in future DOD and manufacturer decisions about the design, application, and safety of LNB technology, through CERL's world-wide web (WWW) URL:

<http://www.cecer.army.mil>.

2 Facility Identification

CERL identified 32 U.S. Army and other facilities to contact for the survey, as well as contact information for persons or organizations with information on U.S. Air Force and U.S. Navy installations operating LNBs. The 32 installations identified by CERL were:

Aberdeen Proving Ground	Fort Carson	Fort Hood
Carlisle Barracks	Fort Dix	Fort Jackson
Fort Belvoir	Fort Drum	Fort Knox
Fort Benning	Fort Eustis	Fort Leonard Wood
Fort Bragg	Fort George G. Meade	Fort Lewis
Fort Campbell	Fort Gordon	Fort McNair
Fort Monmouth	Fort Stewart	Pentagon Boiler Plan
Fort Myer	Fort Wainwright	Picatinny Arsenal
Fort Riley	Fort Lee	Redstone Arsenal
Fort Rucker	Fort Gillem	West Point
Fort Sill	NASA	

TMS contacted Mr. Henry Studebaker* for information on Navy facilities operating low-NOx burners. Mr. Studebaker provided a list of 12 Navy and Marine installations that had installed LNBs, and appropriate contacts at these locations:

Subase New London	Naval Education and Training Center
Naval District Washington DC	Marine Corps Air Ground Combat Center
Naval Air Station Whidbey Island	Naval Medical Center San Diego
Naval Station Everett	Marine Corps Air Station New River
Naval Subase King's Bay	Subase Point Loma
Naval Shipyard Puget Sound	Naval Amphibious Base San Diego

Mr. Studebaker also provides updated contact information for Mr. Gerry Doddington,† who was the reference listed by CERL for information on U.S. Air

* A. Henry Studebaker, P.E. Mechanical Engineer, Naval Facilities Engineering Service Center, 1100 23rd Ave., Port Hueneme, CA, (805) 982-3524.

† Gerry Doddington, Air Force Civil Engineer Support Agency, 139 Barnes Drive, Suite 1, Tyndall AFB, FL, (850) 283-6343.

Force facilities using LNB technology. Mr. Doddington provided TMS with a list of six Air Force Bases (AFBs) to contact:

Andrews AFB	McGuire AFB
Brooks AFB	Robins AFB
Langley AFB	Vandenberg AFB

The 32 facilities identified by the CERL combined with the 12 Navy and 6 Air Force facilities combined to provide TMS with a list of 50 facilities to contact, the maximum number of facilities specified in the Statement of Work (SOW). Appendix A lists complete contact information.

3 Survey Questionnaire and Data Base Development

Questionnaire Development

TMS personnel then created a questionnaire for distribution to the facilities that would elicit responses containing comprehensive information on the boilers and LNBs. The questionnaire was designed to be specific and thorough, but brief, to prevent any undue burden on DOD facility personnel. The survey asked the same seven basic questions suggested in the Research Plan. Appendix B includes the text of the questionnaire.

A data base was also developed by TMS personnel for storing contact information and data contained in the responses to the questionnaire. The data base was designed using Microsoft Access. Its design was similar to the questionnaire format to simplify the data entry process. Appendix C lists the survey results.

Questionnaire Testing and Distribution

Contact information for each of the 50 facilities was established by telephone contact with the Office of the Director of Public Works (DPW) or equivalent at each facility. The e-mail address and phone number of the DPW or responsible party was recorded in the data base. The DPW or equivalent offices were advised of the pending questionnaire and encouraged to return a completed questionnaire in a timely manner. When redirected by the DPW to a different office, TMS personnel recorded contact information for the recommended office.

Before being distributed to all 50 facilities, the questionnaire was tested on five facilities: Langley AFB, Aberdeen Proving Ground, Fort Belvoir, Fort Benning, and Fort Bragg. The survey was sent to the DPW or equivalent office via e-mail on 5 November 1998. TMS personnel also contacted DPW offices at the facilities by telephone to advise them of the objective and importance of the survey and to verify the e-mail address. The purpose of the test was to identify any changes to the questionnaire or data base that might result in better or more complete reporting of data relevant to the objective of the survey. Unfortunately, TMS

received only one response — a note from Fort Belvoir indicating that the facility did not, in fact, operate any LNBs. After 2 weeks without further response, it was decided to proceed with the survey without altering the questionnaire. The questionnaire was then e-mailed to the contact established at each of the other 45 facilities over the period of 24 November to 5 December 1998.

Data from responses to the questionnaire was entered into the data base on receipt by TMS personnel. Some of the responses specified two or more different types of boilers operating LNBs. In such a case, separate records in the data base were used for each type of boiler. If different types of boilers were not specified, but multiple boilers were indicated, only one record was made. If the facility response contained separate answers to the questionnaire for each boiler, multiple records were used.

4 Results

Appendix C lists the survey results. The following sections report the level of response to the questionnaire, a scientific analysis of the data collected, and a subjective analysis of the survey.

Level of Response

The overall level of response to the survey was low. Twenty-eight facilities responded to the survey:

Andrews AFB	Fort Wainwright
Brooks AFB	Langley AFB
Fort Belvoir	Marine Corps Air Ground Combat Center
Fort Benning	McGuire AFB
Fort Campbell	Naval Amphibious Base San Diego
Fort Dix	Naval District Washington DC
Fort Gillem	Naval Education and Training Center
Fort Gordon	Naval Medical Center San Diego
Fort Lee	Naval Shipyard Puget Sound
Fort Lewis	Naval Station Everett
Fort Monmouth	Picatinny Arsenal
Fort Riley	Subase Point Loma
Fort Rucker	Vandenberg AFB
Fort Stewart	West Point

In addition to the facilities not responding, many of the contacts replied with a negative response, i.e., the facility did not operate any boilers with LNBs. The 15 facilities reporting no LNBs are tabulated below, along with notes about the boilers at the facility.

Table 1. Facilities reporting no LNBs.

DOD Facility	Notes
Brooks AFB	Natural gas boilers
Everett, WA	Natural gas boilers
Fort Belvoir	Now converting to natural gas operation
Fort Benning	Many small boilers
Fort Campbell	LNB approved but never received or installed
Fort Gillem	Natural gas boilers
Fort Lewis	Natural gas boilers
Fort Monmouth	Natural gas boilers
Fort Rucker	
Fort Stewart	
Fort Wainwright	Coal-fired boilers
Fort Lee	Natural gas boilers
Langley AFB	
McGuire AFB	Just began retrofit; will complete 12/99
Picatinny Arsenal	LNB installation to begin in April, will complete 12/99

The contact at one of these facilities (Fort Rucker) replied that, even after researching literature on the boilers and querying boiler operations personnel, he was not sure whether his facility had LNBs. He requested that TMS personnel supply him with information to identify which of Fort Rucker's boilers might be equipped with the technology. For the purposes of this survey, Fort Rucker was classified as not having LNBs installed.

Of these 15 facilities, several completed the questionnaire, citing the installation of natural gas boilers as a NO_x-reducing technology. For this reason, facilities that completed the questionnaire (but reported no LNBs) were included in the data base.

The remaining 13 facilities supplied responses to the questionnaire indicating the presence of LNBs on facility boilers. The thoroughness of these responses varied, from some that provided detailed answers to each question to some that responded to the questionnaire by returning an existing parallel document such as emissions reports or internal reviews. TMS personnel culled as much relevant data from these documents as possible, but there are gaps in the data for several facilities. The 13 facilities that responded to the questionnaire and reported operating LNBs were:

Andrews AFB	Naval Education and Training Center
Fort Dix	Naval Medical Center
Fort Gordon	Naval Shipyard Puget Sound
Fort Riley	Subase Point Loma
Marine Corps Air Ground Combat Center	Vandenberg AFB
Naval Amphibious Base	West Point Military Academy
Naval District Washington DC	

Summary of Findings

The 13 facilities returning a positive response to the questionnaire provided data to account for 16 records in the data base. Facilities responding with completed questionnaires but operating natural gas burners not equipped with nominal LNBs provided data for another 10 records.

The resulting 26-record data base does not conclusively indicate a problem with LNB operations in the field, but does indicate some concern on the part of boiler operating personnel. Ten of the 16 LNB records, or 62.5 percent, indicate that problems have been encountered during installation, commissioning, or operation. The low level of response indicates that facilities may have responded only if they had complaints about the LNBs. Even if all 22 nonresponding facilities have LNBs operating without problems, at least 26 percent of the possible LNB facilities have encountered significant problems. The type of problem most frequently mentioned in the 16 LNB records is operational difficulties, followed by commissioning and installation problems.

The most frequently cited operational problem seems to be compromised emissions performance. The LNBs do not seem to be delivering the reduced NO_x levels promised. In addition, several facilities report problems with flameout or other flame problems. At least eight of the 16 LNB facilities reported some type of flame control problems relating to either O₂ trim, gas line pressure, control system, or flame shape, with O₂ trim being the most frequently blamed cause. Other operational problems mentioned include electrode failure, excessively high superheat temperatures, Flue Gas Recirculator (FGR) problems, and excessive vibration during operation. The facilities indicated that some problems were solved by modifying the equipment in the field, but the result is a customized burner that is not easy to replace.

Table 2. Operational problems and possible solutions.

Problem	Possible Solution
NOx levels not reduced to correct levels	Install inlet damper to throttle air opening and increase FGR flow Change burner tips for different flame shape
Flameout	Resize orifice in pressure regulator to stabilize gas pressure Adjust location or flow of FGR Add screen around register
Premature electrode failure	Cyclical loading problems – may need to downsize burner
Excessive Vibration	Install plates in boiler breaching to reduce vortices
O ₂ control	Add O ₂ trim system

Installation and commissioning problems with the burners seem to be related to each other. Three of the 16 NOx facilities complained about the failure of installation contractors to help throughout the troubleshooting process. However, one response actually commended the installation contractor for quality work and perseverance. Two facilities also mentioned that problems could be traced to the fact that, with improved efficiency, the boilers became oversized for the application. Other installation and commissioning problems cited included problems with two boilers sharing a common stack, improper burner tips, and problems interfacing new equipment with dirty equipment.

Table 3. Installation and commissioning problems and possible solutions.

Problem	Possible Solution
Ignition problems in common stack configuration	Install stack dampers
Insufficient support by installation contractor	Establish higher standards for contractors Define contractual requirements for support through commissioning stages Use contractors with specific experience with LNB installation
Field modification of burners makes replacement difficult	Establish communication with manufacturer to voice concerns

In addition to the data entered into the data base, the survey provided an opportunity for informal discussion with site staff on LNB successes and shortcomings. In the course of conducting the survey, TMS personnel had the opportunity to interact via telephone and e-mail with boiler operations personnel at almost all of the 50 facilities contacted in the survey. It is evident that some facilities with valuable input on LNB operation failed to return a questionnaire or were excessively brief in responding to the questionnaire. Some subjective observations made by TMS personnel based on conversations with DOD facility personnel were:

1. With increasingly stringent emissions limits, low NOx technology is becoming a preferred option when boiler modernization projects are undertaken at DOD facilities.
2. Many facilities are also retrofitting boilers to operate on natural gas instead of fuel oil or coal, for the same reasons.
3. Retrofitting boilers with LNB technology has resulted in much more frequent operational problems than installing new boilers designed to operate with LNBs.
4. Flameout is a common problem in boilers that have been retrofitted with LNBs. Opinions on exactly why the flameout occurs seem to be as numerous as the facilities.
5. There is a widespread lack of knowledge in the field about LNB technology, and what exactly constitutes a "Low-NOx Burner."
6. Contractors are frequently blamed for problems with boiler operations after installation of LNBs.
7. Problems with Flue Gas Recirculation (FGR) are frequent after installation of LNB equipment. FGR design or flow rate typically need to be adjusted to achieve reduced NOx emissions.

5 Conclusions and Recommendations

The data collected in this survey did not conclusively show that LNBs are chronically problematic, but a majority of the LNB-equipped boilers recorded in the data base reported problems with operation, installation, or commissioning. The most frequently reported problems were the failure of the unit to reduce NOx emissions to the level promised, and flame instability caused by a variety of factors. Although survey respondents reported numerous innovative attempts to solve these problems, the LNBs seem to be a source of significant frustration for boiler operations personnel.

To further pinpoint and minimize problems with the technology, it is recommended that future data collection begin by choosing several LNB facilities to participate in a dialogue in which problems and solutions can be discussed in greater detail. It may be useful to examine similarities and differences in the operating environments of different facilities, the configuration of multiple-boiler systems, and the exact installation techniques best suited to LNB retrofits.

The low level of response indicates that a written or electronic survey may not be the most effective method of collecting LNB operation information from the field. Facility personnel are reluctant to devote significant time or effort to written questions. Also, a general survey limits the ability to focus on specific problems at specific sites. A more effective and efficient method of collecting information on LNB operation may be to focus on approximately five facilities and develop a detailed history and analysis of LNB operation at each site. Problems could be investigated thoroughly, and a protocol for solving recurring LNB problems could be developed.

Appendix A: Contacts

U.S. Military Academy West Point (U.S. Army)
USMA West Point
West Point, NY 10996-1592
Environmental Group

Andrews AFB (U.S. Air Force)
Mechanical Engineer
89 CES/CEOE
B3446 Tennessee Ave.
Andrews AFB, MD 20762-4803

Fort Lee (U.S. Army)
Director of Public Works
ATTN: ATZM-E
1816 Shop Road
Fort Lee, VA 23801-1604

Redstone Arsenal (U.S. Army)
ATTN: AMSMI-RA-DPW
Redstone Arsenal, AL 35898-5340
Director of Public Works

Fort Lewis (U.S. Army)
Director of Public Works
ATTN: AFZH-PW, MS17
Box 339500
Fort Lewis, WA 98433-9500

Fort Benning (U.S. Army)
Director of Public Works
USAIC, DPW, Meloy Hall, Bldg. 6
Fort Benning, GA 31905

Fort Carson (U.S. Army)
Director of Public Works
ATTN: AFZC-DPW
805 Tevis Street
Fort Carson, CO 80913-4001

Fort Rucker (U.S. Army)
Director of Public Works
ATTN: ATZQ-DPW
Fort Rucker, AL 36362-5135

Fort Jackson (U.S. Army)
Director of Public Works
ATTN: ATZJ-PW
Fort Jackson, SC 29207-5650

Fort Drum (U.S. Army)
Director of Public Works
85 First Street West
ATTN: AFZS-PW
Fort Drum, NY 13602-5097

Fort Hood (U.S. Army)
Director of Public Works
ATTN: AFZF-PW
Fort Hood, TX 76544-5057

Fort Gordon (U.S. Army)
Director of Public Works
ATTN: ATZH-DI
Fort Gordon, GA 30905-5040

Naval Station Everett (U.S. Navy)
Energy Manager
Naval Station Everett
Everett, WA

Aberdeen Proving Ground (U.S. Army)
Director of Public Works
ATTN: STEAP-FE
Aberdeen Proving Ground, MD 21005-5055

Naval Medical Center San Diego (U.S. Navy)
General Foreman
Naval Medical Center
San Diego, CA

Point Loma (U.S. Navy)
General Foremen
San Diego, CA

Naval Amphibious Base (U.S. Navy)
General Foreman
San Diego, CA

Fort McNair (U.S. Army)
U.S. Army Military District of Washington
Chief, Environmental Support Division
ATTN: ANEN-ES
Fort McNair
Washington, DC 20319-5050

Fort Riley (U.S. Army)
Director of Public Works
ATTN: AFZN-PW
Fort Riley, KS 66442-6000

Fort Belvoir (U.S. Army)
Director of Public Works
ATTN: ANFB-PW
Fort Belvoir, VA 22060-5130

Fort George G. Meade (U.S. Army)
Director of Public Works
ATTN: ANME-PW
Fort George G. Meade, MD 20755-5115

Fort Gillem (U.S. Army)
Forest Park, GA

Fort Knox (U.S. Army)
Director of Public Works
U.S. Army Armor Center and Fort Knox
ATTN: ATZK-PW
Fort Knox, KY 40121-5000

Picatinny Arsenal (U.S. Army)
Director of Public Works
ATTN: AMSTA-AR-PW, Bldg. 3002
Picatinny Arsenal, NJ 07806-5000

Naval Air Station Whidbey Island (U.S. Navy)
Utility Director
Naval Air Station Whidbey Island
Whidbey Island, WA

Pentagon Boiler Plant (U.S. Army)

Naval Shipyard Puget Sound (U.S. Navy)
Mechanical Engineer
Puget Sound, WA

Brooks AFB (U.S. Air Force)
Superintendent of HVAC
Brooks AFB
San Antonio, TX

Fort Campbell (U.S. Army)
Acting Director of Public Works
ATTN: AFZB-DPW
16th & Ohio Street
Fort Campbell, KY 42223-5130

Vandenberg AFB (U.S. Air Force)
Mechanical Engineer
Vandenberg AFB
Lompoc, CA

Langley AFB (U.S. Air Force)

Fort Monmouth (U.S. Army)
Director of Public Works
USA Garrison
ATTN: SELFM-PW
Fort Monmouth, NJ 07703-5108

Fort Leonard Wood (U.S. Army)
Director of Public Works
ATTN: ATZT-DPW
Fort Leonard Wood, MO 65473-5000

Subase New London (U.S. Navy)
Utility Director
New London, CT

Fort Stewart (U.S. Army)
Director of Public Works
ATTN: AFZP-DE
Bldg. 1101, Utility Street
Fort Stewart, GA 31314-5000

Robins AFB (U.S. Air Force)

Fort Eustis (U.S. Army)
Director of Public Works
USATCFE
Washington Blvd., Bldg. 1407
Fort Eustis, VA 23604-5306

Fort Myer (U.S. Army)
Director of Public Works
ATTN: ANMY-PWZ
Fort Myer, VA 22211-5050

Fort Bragg (U.S. Army)
Director of Public Works
ATTN: AFZA-PW
Fort Bragg, NC 28307-5000

MCAS New River (DOD)
Assistant Facility Manager
New River, NC

Naval Education and Training Center (U.S. Navy)
Public Works Engineering Division
Supervisor Planning
Naval Education and Training Center , RI

Carlisle Barracks (U.S. Army)
Director of Public Works
ATTN: ATZE-DPW
330 Engineer Avenue
Carlisle Barracks, PA 17013-5002

Fort Dix (U.S. Army)
Director of Public Works
ATTN: AFRC-FA-PW, Bldg. 5320
Fort Dix, NJ 08640-5500

Naval Subbase Kings Bay (U.S. Navy)
Energy Engineer
Kings Bay, GA

Naval District Washington DC (U.S. Navy)
Mechanical Engineer
Washington, DC

Fort Sill (U.S. Army)
Director of Public Works
ATTN: ATZR-E
Fort Sill, OK 73503-5100

Fort Wainwright (U.S. Army)
Director of Public Works
ATTN: APVR-WPW
Fort Wainwright, AK 99703-6500

Appendix B: Questionnaire

The U.S. Army Construction Engineering Research Laboratory (CERL) has commissioned a survey of Department of Defense facilities that have installed burners to control emissions of nitrogen oxides (NO_x) on gas- and oil-fired boilers. Your facility has been identified as operating a boiler (or boilers) that use this important technology.

Below is a questionnaire requesting information on the performance of these boilers. Please take a few minutes to answer each inquiry completely. Insert answers to the questions below and feel free to add further comments or information that you think is important under Question 7 at the end of the questionnaire. Please respond by Friday, January 15, 1999.

If you have questions or problems, call me at (301) 670-6390, Ext. 34. Thank you for your help.

Peter Herz
Technology and Management Services, Inc.
18757 North Frederick Road
Gaithersburg, MD 20879
(301) 670-1942 (FAX)
pherz@tms-hq.com

CERL Low NOx Burner Survey**Question 1. Please identify the characteristics of the boiler(s):**

Boiler Type:

Boiler Size MWe:

and/or

Boiler Size MBtu/hr of Steam

Boiler Fuel:

Boiler Description:

Boiler Vendor:

Serial Number:

Date Installed:

Number of Burners:

Burner Operating System:

Other Burner Operating System:

Question 2. Please state your air permit requirements, including NOx emission limit.

Requirements:

NOx Limit: lb/mBtu

Question 3. Please identify any recent major modifications, including low NOx burners (LNB).

LNB Type:

LNB Vendor:

LNB Installation Date:

Date of Major Modification:

Other Modifications:

Flame Scanner (Yes or No):

Flame Scanner Vendor:

Question 4. Please describe the LNB installation problems you have experienced, the solutions that you have implemented to solve the problems, and whether these solutions have been successful.

Installation Problems:

Installation Solutions:

Question 5. Please describe the LNB commissioning problems you have experienced, the solutions that you have implemented to solve the problems, and whether these solutions have been successful.

Commissioning Problems:

Commissioning Solutions:

Question 6. Please describe the LNB operational problems you have experienced, the solutions that you have implemented to solve the problems, and whether these solutions have been successful.

Operational Problems:

Operational Solutions:

Question 7. Are there any other issues or problems regarding boiler safety that you can identify?

Appendix C: Survey Results

Facility ID	27	Boiler Descriptions	Copper Fin II
Facility Name	Fort Benning	Boiler Serial No.	
Boiler Type	Multiple Boilers (over 50)	Date Boiler Installed	
Other Type		LNB Install Date	
Boiler Size	300 to 1800 Mbtu/hr	LNB Vendor	
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	
Burner System		NOx Emission Limit	0
Other Burner System		Flame Scanner?	No
No. of Burners		Flame Scanner Vendor	
Boiler Vendor	Lochinvar	Permit Requirements	The state of Georgia does not have a limit on NOx emissions for boilers of these sizes
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
The manufacturer provided an extraordinary class on the O&M of the boilers at the conclusion of the project.			
Description of Installation Solutions			
The instructor disassembled and reassembled the boilers in the on site instruction. There are not any other issues or problems on these boilers that we have any comments on.			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			
Fort Benning has recently completed a project in which we shut down a central plant and installed about 80 new boilers in about 40 buildings. All 80 or so boilers were Lochinvar Copper Fin II type which are low NOx (*9.9ppm, I think).			

Rank	First Name	Last Name	Title		
			USAIC, Director of Public Works, Meloy Hall		
Address		City	State	Postal Code	
USAIC, DPW, Meloy Hall, Bldg. 6		Fort Benning	GA	31905	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	39	Boiler Descriptions	Field Erected, side burner installed, original coal fired
Facility Name	Fort Dix	Boiler Serial No.	
Boiler Type	Water Tube	Date Boiler Installed	
Other Type		LNB Install Date	01/22/98
Boiler Size	50,000 lbs/hr	LNB Vendor	S.T. Johnson
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Forced Draft, Gas Only, Recirculating exhaust gas
Burner System		NOx Emission Limit	0.1 lb/Mbtu
Other Burner System		Flame Scanner?	yes
No. of Burners	2 per boiler	Flame Scanner Vendor	Fireye #45UV5
Boiler Vendor	Keeler	Permit Requirements	
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
None			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title	
			Director of Public Works	
Address		City	State	Postal Code
ATTN: AFRC-FA-PW, Bldg. 5320		Fort Dix	NJ	08640-5500
Work Phone	Ext.	Fax Number	E-Mail Address	

Facility ID	2	Boiler Descriptions	Low-pressure Scotch Marine
Facility Name	Gillem	Boiler Serial No.	01096778 & 01096777
Boiler Type	Other (2 Boilers)	Date Boiler Installed	1/1/77
Other Type		LNB Install Date	
Boiler Size	10,205,800 Mbtu/hr	LNB Vendor	
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	Propane	LNB Type	None
Burner System	Other	NOx Emission Limit	
Other Burner System	Fire Eye EB 700	Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	
Boiler Vendor	Cleaver Brooks	Permit Requirements	49.9 tpy (all sources) for Nox
Description of other Modifications			
Description of Commissioning Problems			
N/A			
Description of Commissioning Solutions			
Description of Installation Problems			
N/A			
Description of Installation Solutions			
Description of Operational Problems			
N/A			
Description of Operational Solutions			
Other Comments			
None			

Rank	First Name	Last Name	Title
Address		City	State Postal Code
		Forest Park	GA
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	24	Boiler Descriptions	
Facility Name	Fort Gordon	Boiler Serial No.	
Boiler Type	10 Natural Gas boilers, no LNB's	Date Boiler Installed	1965-97
Other Type		LNB Install Date	
Boiler Size	13,800-35,850 lbs/hr	LNB Vendor	
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	#2 fuel oil	LNB Type	
Burner System		NOx Emission Limit	0
Other Burner System		Flame Scanner?	No
No. of Burners		Flame Scanner Vendor	
Boiler Vendor	Cleaver Brooks, Nebraska Boiler, Erie City Ironwor	Permit Requirements	The emission limits for NOx in the new boilers is: 0.20 lbs per MBtu gaseous fuel; 0.30 lbs per MBtu liquid fossil fuel. Older boilers: 100 tons per year or not to exceed 100 micrograms per cubic meter at ground level.
Description of other Modifications			
Description of Commissioning Problems			
N/A			
Description of Commissioning Solutions			
Description of Installation Problems			
N/A			
Description of Installation Solutions			
Description of Operational Problems			
N/A			
Description of Operational Solutions			
Other Comments			
N/A			

Rank	First Name	Last Name	Title		
			Director of Public Works		
Address		City	State	Postal Code	
ATTN: ATZH-DI		Fort Gordon	GA	30905-5040	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	14	Boiler Descriptions	Scotch Marine Firetube
Facility Name	Fort Lewis	Boiler Serial No.	1-L-82519, 2-L-82518, 3-L-82517
Boiler Type	Five Boilers	Date Boiler Installed	7/21/87
Other Type		LNB Install Date	
Boiler Size	2x20.92, 2x13.40, 1x25.11 MBtu/hr	LNB Vendor	
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	and #2 0.01% sulfur) Fuel Oil	LNB Type	None
Burner System	Honeywell	NOx Emission Limit	0
Other Burner System	CBs	Flame Scanner?	No
No. of Burners	1 each	Flame Scanner Vendor	
Boiler Vendor	Clever Brooks	Permit Requirements	0.1 lbs/MBtu for Natural gas and 0.3 lbs/MBtu on fuel oil
Description of other Modifications			
Description of Commissioning Problems			
None			
Description of Commissioning Solutions			
N/A			
Description of Installation Problems			
None			
Description of Installation Solutions			
N/A			
Description of Operational Problems			
None			
Description of Operational Solutions			
N/A			
Other Comments			
None			

Rank	First Name	Last Name	Title
			Director of Public Works
Address		City	State Postal Code
ATTN: AFZH-PW, MS17 Box 339500		Fort Lewis	WA 98433-9500
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	3	Boiler Descriptions	
Facility Name	Fort George G. Meade	Boiler Serial No.	
Boiler Type	Six Boilers	Date Boiler Installed	
Other Type		LNB Install Date	
Boiler Size	(2x48,000), (3x13,800), (9,000) Mbtu/hr	LNB Vendor	N/A
Boiler Fuel	No. 2 Oil	Date of Major Mod	
Combination Fuels		LNB Type	N/A; may install LNBs in future
Burner System		NOx Emission Limit	
Other Burner System		Flame Scanner?	No
No. of Burners		Flame Scanner Vendor	
Boiler Vendor		Permit Requirements	
Description of other Modifications			
N/A			
Description of Commissioning Problems			
N/A			
Description of Commissioning Solutions			
Description of Installation Problems			
N/A			
Description of Installation Solutions			
Description of Operational Problems			
N/A			
Description of Operational Solutions			
Other Comments			
None			

Rank	First Name	Last Name	Title	
			Director of Public Works	
Address		City	State	Postal Code
ATTN: ANME-PW		Fort George G. Meade	MD	20755-5115
Work Phone	Ext.	Fax Number	E-Mail Address	

Facility ID	5	Boiler Descriptions	Field erected, multiburner, balanced draft with tubular air heater
Facility Name	Picatinny Arsenal	Boiler Serial No.	6899 & 6901
Boiler Type	Water Tube (2 identical boilers)	Date Boiler Installed	1/1/54
Other Type		LNB Install Date	
Boiler Size		LNB Vendor	burners by January 2000
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	#6 Fuel Oil	LNB Type	Both boilers are schedule to be equipped with new
Burner System	Natural Gas or #6 fuel oil	NOx Emission Limit	
Other Burner System		Flame Scanner?	No
No. of Burners	4	Flame Scanner Vendor	
Boiler Vendor	Combustion Engineering Co.	Permit Requirements	0.100 lb/Mbtu for Natural Gas; 0.280 lb/Mbtu for Residual Fuel Oil
Description of other Modifications			
Description of Commissioning Problems			
N/A			
Description of Commissioning Solutions			
N/A			
Description of Installation Problems			
N/A			
Description of Installation Solutions			
N/A			
Description of Operational Problems			
N/A			
Description of Operational Solutions			
N/A			
Other Comments			
N/A			

Rank	First Name	Last Name	Title
			Director of Public Works
Address		City	State Postal Code
Picatinny Arsenal ATTN: AMSTA-AR-PW, Bldg. 3002		Picatinny Arsenal	NJ 07806-5000
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	10	Boiler Descriptions	Water Tube Fire Box Constructed (2 each)
Facility Name	Fort Riley	Boiler Serial No.	Nat. Board # 19312; Nat. Board # 19313
Boiler Type	Two boilers-Babcock & Wilcox type "FF"	Date Boiler Installed	1955
Other Type		LNB Install Date	9/1/98
Boiler Size	27.5 Mbtu/hr each	LNB Vendor	Coen
Boiler Fuel	Natural Gas	Date of Major Mod	9/1/98
Combination Fuels	Oil	LNB Type	Forced Draft
Burner System	Honeywell SCAN 3000 Automatic Combustion Control	NOx Emission Limit	.10
Other Burner System		Flame Scanner?	No
No. of Burners	1 each	Flame Scanner Vendor	Fireye
Boiler Vendor	Babcock & Wilcox	Permit Requirements	No stated limits. 0.10 lbs/Mbtu for natural gas
Description of other Modifications			
Description of Commissioning Problems			
None			
Description of Commissioning Solutions			
Description of Installation Problems			
None			
Description of Installation Solutions			
Description of Operational Problems			
None			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title
			Director of Public Works
Address		City	State Postal Code
ATTN: AFZN-PW		Fort Riley	KS 66442-6000
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	18	Boiler Descriptions	Water tube
Facility Name	U.S. Military Academy West Point	Boiler Serial No.	
Boiler Type	2 boilers	Date Boiler Installed	
Other Type		LNB Install Date	11/1/99
Boiler Size	150 Mbtu/hr	LNB Vendor	
Boiler Fuel	#5 Fuel Oil	Date of Major Mod	
Combination Fuels		LNB Type	
Burner System	Other	NOx Emission Limit	0
Other Burner System		Flame Scanner?	No
No. of Burners	4 each	Flame Scanner Vendor	
Boiler Vendor	Keeler	Permit Requirements	No. 5 fuel is 0.30 and Natural Gas is 0.1lb/Mbtu
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
We currently meet NOx RACT by fuel switching at our Central Power Plant (This plant consists of the two largest boilers and the next one down in size). NOx levels exceed limits.			
Description of Installation Solutions			
COEN believes that using different burner tips which shape the flame differently will reduce the NOx emissions to a level where fuel switching is no longer required (i.e., 0.30 lbs/million Btu or less).			
Description of Operational Problems			
Description of Operational Solutions			
We cannot run the two largest boilers and full capacity right now and could not complete the testing of various tips supplied by COEN. We will be able to resume that testing in January 1999. At low fire, in November of 1998, we were able to (see below)			
Other Comments			
Achieve[d] 0.18 lbs/MBtu in the breaching, but not yet tested at the stack and through 12 or 15 turndowns. Other boilers appear to be meeting standards.			

Rank	First Name	Last Name	Title		
			Environmental Group		
Address		City	State	Postal Code	
USMA West Point		West Point	NY	10996-1592	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	19	Boiler Descriptions	Water tube
Facility Name	U.S. Military Academy West Point	Boiler Serial No.	
Boiler Type	Other- 3 boilers	Date Boiler Installed	
Other Type		LNB Install Date	
Boiler Size	50 to 150 Mbtu/hr	LNB Vendor	
Boiler Fuel	No. 5 Oil	Date of Major Mod	
Combination Fuels	No. 5 Oil/Natural Gas	LNB Type	None
Burner System		NOx Emission Limit	0
Other Burner System		Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	
Boiler Vendor	Tampella; Bigelow	Permit Requirements	No. 5 fuel oil is 0.30 and Natural Gs is 0.10
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title	
			Environmental Group	
Address		City	State	Postal Code
USMA West Point		West Point	NY	10996-1592
Work Phone	Ext.	Fax Number	E-Mail Address	

Facility ID	48	Boiler Descriptions	
Facility Name	Andrews AFB	Boiler Serial No.	
Boiler Type	3 new Dual Fuel	Date Boiler Installed	7/1998
Other Type		LNB Install Date	07/13/98
Boiler Size	85.4 mbtu/hr	LNB Vendor	Forney Corporation
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	#6 Fuel Oil	LNB Type	
Burner System		NOx Emission Limit	.10 lbs/Mbtu
Other Burner System		Flame Scanner?	No
No. of Burners		Flame Scanner Vendor	
Boiler Vendor	English	Permit Requirements	
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
Description of Installation Solutions			
Description of Operational Problems			
Getting the burners to perform as specified (reach NOx limit) with natural gas			
Description of Operational Solutions			
Burners were field modified; each is now custom and can't be replaced			
Other Comments			

Rank	First Name	Last Name	Title		
			Mechanical Engineer		
Address		City	State	Postal Code	
89 CES/CEOE, B3446 Tennessee Ave.		Andrews AFB	MD	20762-4803	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	1	Boiler Descriptions	Cast Iron Section
Facility Name	Brooks AFB	Boiler Serial No.	F92-833
Boiler Type	Hot Water, Heating	Date Boiler Installed	March 1993
Other Type		LNB Install Date	
Boiler Size	560,000 Mbtu/hr	LNB Vendor	
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	
Burner System	Other	NOx Emission Limit	
Other Burner System	Power Flame, Model JR30A 10 HBS+6	Flame Scanner?	Yes
No. of Burners	1	Flame Scanner Vendor	Fire Eye
Boiler Vendor	HB Smith	Permit Requirements	None required.
Description of other Modifications			
Description of Commissioning Problems			
None			
Description of Commissioning Solutions			
Description of Installation Problems			
None, contractor installed			
Description of Installation Solutions			
Description of Operational Problems			
None			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title		
			Superintendent of HVAC		
Address			City	State	Postal Code
Brooks AFB			San Antonio	TX	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	33	Boiler Descriptions	
Facility Name	McGuire AFB	Boiler Serial No.	
Boiler Type	3 boilers now being retrofitted	Date Boiler Installed	
Other Type		LNB Install Date	
Boiler Size	61.8 Mbtu/hr	LNB Vendor	
Boiler Fuel		Date of Major Mod	
Combination Fuels		LNB Type	
Burner System		NOx Emission Limit	0
Other Burner System		Flame Scanner?	No
No. of Burners	0	Flame Scanner Vendor	
Boiler Vendor		Permit Requirements	In September 1998, McGuire began a project to renovate/rebuild three large boilers (61.8 MMBtu/hr) with low NOx burners. The estimated completion date for these boilers is December 1999.
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
Installation is just beginning (September 1998) and will be completed December 1999			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title		
			Chief of Infrastructure		
Address			City	State	Postal Code
McGuire AFB			Wrightstown	NJ	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	44	Boiler Descriptions	fire tube boiler
Facility Name	Vandenberg AFB	Boiler Serial No.	
Boiler Type	Fire Tube	Date Boiler Installed	1994
Other Type		LNB Install Date	09/03/98
Boiler Size	2.05 MBtu/hr	LNB Vendor	S.T. Johnson
Boiler Fuel	Propane	Date of Major Mod	
Combination Fuels		LNB Type	Fully modulating diffuser head forced draft burner
Burner System		NOx Emission Limit	
Other Burner System		Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	
Boiler Vendor	Kewanee	Permit Requirements	
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title		
			Engineer		
Address			City	State	Postal Code
Vandenberg AFB			Lompoc	CA	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	45	Boiler Descriptions	Model HPG-2500 low-pressure steam boiler
Facility Name	Vandenburg AFB	Boiler Serial No.	
Boiler Type	Low-pressure steam boiler	Date Boiler Installed	12/31/98
Other Type		LNB Install Date	12/31/98
Boiler Size	2.5 Mbtu/hr	LNB Vendor	Ajax
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	premix manifold
Burner System		NOx Emission Limit	
Other Burner System		Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	
Boiler Vendor	Ajax	Permit Requirements	
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title		
			Engineer		
Address		City	State	Postal Code	
Vandenburg AFB		Lompoc	CA		
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	46	Boiler Descriptions	New water tube boiler
Facility Name	Vandenburg AFB	Boiler Serial No.	
Boiler Type	Water Tube	Date Boiler Installed	3/18/98
Other Type		LNB Install Date	03/18/98
Boiler Size	2.5MBtu/hr	LNB Vendor	Alzeta Corporation
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Pyromat Radiation Stabilized power burner
Burner System		NOx Emission Limit	
Other Burner System		Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	
Boiler Vendor	PVI Industries, Inc.	Permit Requirements	
Description of other Modifications			
Description of Commissioning Problems			
1) Inconsistent gas line pressure caused flameout; 2) Clogged heat exchanger in old hot water tank			
Description of Commissioning Solutions			
1) Restricted the gas line by resizing the orifice in the pressure regulator; 2) Removed and cleaned heat exchanger			
Description of Installation Problems			
Description of Installation Solutions			
Description of Operational Problems			
The electrodes wore out prematurely due to cyclical loading on the boiler causing it to turn on and off.			
Description of Operational Solutions			
It was determined that the boiler was oversized for the application, so the burner will be replaced with a smaller unit.			
Other Comments			

Rank	First Name	Last Name	Title		
			Engineer		
Address		City	State	Postal Code	
Vandenburg AFB		Lompoc	CA		
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	16	Boiler Descriptions	Water Tube
Facility Name	Naval District Washington DC	Boiler Serial No.	D2898 & D2900
Boiler Type	Two Boilers	Date Boiler Installed	4/93
Other Type		LNB Install Date	4/1/93
Boiler Size	85,000 lbs/hr	LNB Vendor	Peabody
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	#2 fuel oil	LNB Type	ISC-23 Low NOx FlexiPak,
Burner System	Preferred Rimcor PCII	NOx Emission Limit	0.1 lb/Mbtu
Other Burner System	Master Controller run by Allen-Bradley PLC rack	Flame Scanner?	Yes
No. of Burners	1	Flame Scanner Vendor	Peabody
Boiler Vendor	Nebraska	Permit Requirements	.1 - natural gas, 0.2 - fuel oil lb/Mbtu
Description of other Modifications			
Description of Commissioning Problems			
Problems in lighting and maintaining the fire of the boilers (especially on oil).			
Description of Commissioning Solutions			
Description of Installation Problems			
The main problem was the boilers were improperly designed to operate through a common stack. Also poor flame scanners, linkage kinematics for the forced draft fan. Incorrect positioning of gas spuds and incorrect oil tips and plugs.			
Description of Installation Solutions			
The boilers required installation of stack dampers not originally designed to control the lighting and maintaining flame. The linkages for the forced draft fans were removed because of repeated broken rods. Replaced gas spuds settings and oil tips.			
Description of Operational Problems			
At present, we have one operational problem, excessive vibration above 55,000 lb/hr on both boilers. It has not been determined whether the problem is because of the LNB or other equipment.			
Description of Operational Solutions			
We have tried to install plates in the boiler breaching to reduce vortices shown by one study. Yet, this did not work. Another study will be conducted by a difference vendor within the next few months to resolve this issue.			
Other Comments			
Also, flame scanners are extremely sensitive with limited scope due to the burner throat configuration, so there were problems aiming the scanner to view the flame. Scanner aiming is still difficult if moved.			

Rank	First Name	Last Name	Title
			Mechanical Engineer
Address		City	State Postal Code
		Washington	DC
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	23	Boiler Descriptions	Water tube, field ____, side burner in __, original coal fired
Facility Name	Naval Station Everett	Boiler Serial No.	
Boiler Type	Water Tube	Date Boiler Installed	
Other Type		LNB Install Date	1/1/98
Boiler Size	50000	LNB Vendor	S.T. Johnson
Boiler Fuel	Natural Gas	Date of Major Mod	1/22/98
Combination Fuels		LNB Type	____ Draft, Gas Only, Recirculating exchange gas
Burner System	Automatic flame	NOx Emission Limit	0
Other Burner System	Same	Flame Scanner?	Yes
No. of Burners	2	Flame Scanner Vendor	Fireye
Boiler Vendor	Keeler	Permit Requirements	Air permit applications submitted to NJ Dep, April 1998 still 0.1 lb/hr Nox Limit will be required to meet the stack test
Description of other Modifications			
Description of Commissioning Problems			
None			
Description of Commissioning Solutions			
Description of Installation Problems			
No major problems (significant)			
Description of Installation Solutions			
Description of Operational Problems			
None			
Description of Operational Solutions			
Other Comments			
No			

Rank	First Name	Last Name	Title		
			Energy Manager		
Address			City	State	Postal Code
Naval Station Everett			Everett	WA	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	11	Boiler Descriptions	
Facility Name	Naval Station Everett	Boiler Serial No.	WG 3879, W3805, W3806, W3807
Boiler Type	4 Water Tube Boilers	Date Boiler Installed	1/1/95
Other Type		LNB Install Date	
Boiler Size	3x20,000 lb/hr, 1x30,000 lb/hr	LNB Vendor	
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	#2 Fuel Oil	LNB Type	None
Burner System	Cleaver Brooks Dual Fuel (Air & Steam Atomization)	NOx Emission Limit	0.05 lb/Mbtu
Other Burner System		Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	
Boiler Vendor	Cleaver Brooks	Permit Requirements	Plant Design Specs- 400 ppm CO; 30 ppm Nox; 80 ppm Sox
Description of other Modifications			
Description of Commissioning Problems			
None other than normal tuning curves			
Description of Commissioning Solutions			
Description of Installation Problems			
None			
Description of Installation Solutions			
Description of Operational Problems			
None			
Description of Operational Solutions			
Other Comments			
None			

Rank	First Name	Last Name	Title		
			Energy Manager		
Address		City	State	Postal Code	
Naval Station Everett		Everett	WA		
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	17	Boiler Descriptions	Three boilers, two for operation and the third as a backup
Facility Name	Naval Shipyard Puget Sound	Boiler Serial No.	4024/4025/4026
Boiler Type	Riley VR-C3 (mod) Balanced Draft (3 boilers)	Date Boiler Installed	1988
Other Type		LNB Install Date	8/1/96
Boiler Size	146,444KBtu/hr per boiler	LNB Vendor	COEN
Boiler Fuel	No. 2 Oil	Date of Major Mod	8/1/96
Combination Fuels		LNB Type	CPF/LN-30
Burner System	Coen	NOx Emission Limit	0.1
Other Burner System		Flame Scanner?	Yes
No. of Burners	2 per boiler	Flame Scanner Vendor	Fireye
Boiler Vendor	Riley	Permit Requirements	Nox Limit: 0.1 lb/MBtu
Description of other Modifications			
Mod. From coal to natural gas			
Description of Commissioning Problems			
None			
Description of Commissioning Solutions			
None			
Description of Installation Problems			
None			
Description of Installation Solutions			
None			
Description of Operational Problems			
O2 control			
Description of Operational Solutions			
Previous oil O2 control was not a concern as it was a backup fuel. It is much more a concern when we switched to natural gas. Existing forced draft dampers were too coarse a control system in tune for optimum O2. An O2 trim system was added.			
Other Comments			
None			

Rank	First Name	Last Name	Title
			Mechanical Engineer
Address		City	State Postal Code
Naval Shipyard		Puget Sound	WA
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	42	Boiler Descriptions	"SD" Field Erected w/ air preheaters
Facility Name	Naval Education and Training Center	Boiler Serial No.	Riley Stoker 3367 & 3368
Boiler Type	(2)SD 2 drum bent tube front wall-fired	Date Boiler Installed	1959
Other Type		LNB Install Date	01/01/96
Boiler Size	75,000 lbs/hr each	LNB Vendor	DAF
Boiler Fuel	No. 4 Oil/Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Dual fuel, low NOx, induced FGR
Burner System	COEN 2000 BMS with PLC (Allen Bradley) control	NOx Emission Limit	
Other Burner System		Flame Scanner?	No
No. of Burners	1	Flame Scanner Vendor	Fireye
Boiler Vendor	Riley Stoker	Permit Requirements	0.11 lb/Mbtu
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
Description of Installation Solutions			
Description of Operational Problems			
1) Superheat temp high; 2) Improper installation/location of FGR to boiler stack; 3) Hayes controls insufficient for complexity of balanced draft w/ fgr control. 4) Flame long w/ short fuse box			
Description of Operational Solutions			
1) Units were designed for higher temp and pressure, so OK; 2) will relocate tie in to stack; 3) Will replace controls; 4) COEN found the right tips and flame problems were corrected--Flame is more stable on the older Rileys than the Nebraska boiler.			
Other Comments			
Stack monitoring O2 a must (either as alarm or BMS cut out) and recommend installing O2 monitoring in the windbox (depending on size of unit)			

Rank	First Name	Last Name	Title
			Supervisor Planning
Address		City	State Postal Code
Naval Education and Training Center Public Works Engineering Division		City	RI
Work Phone	Ext.	Fax Number	E-Mail Address

Facility ID	41	Boiler Descriptions	"D" package type with economizer.
Facility Name	Naval Education and Training Center	Boiler Serial No.	NEB D2092,
Boiler Type	Lea "D" package type w/economizer	Date Boiler Installed	1/1/87
Other Type		LNB Install Date	1/1/94
Boiler Size	80,000 lbs/hr	LNB Vendor	Coen
Boiler Fuel	No. 4 Oil/Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Dual fuel, low NOx, induced FGR
Burner System	COEN 2000 BMS with PLC (Allen Bradley) control	NOx Emission Limit	
Other Burner System		Flame Scanner?	Yes
No. of Burners	1	Flame Scanner Vendor	Coen
Boiler Vendor	Nebraska	Permit Requirements	Nebraska currently the only permitted boiler, particulate emissions limited to 0.11 bls/MMBtu or 28.35 lbs/hr, whichever is more stringent. Low sulfur fuel (less than 0.5%) also required.
Description of other Modifications			
Description of Commissioning Problems			
"D" type had problems maintaining low NOx at lower firing rates, FGR not sufficient at the firing rates.			
Description of Commissioning Solutions			
Inlet dampers installed to throttle air opening prior to forced draft fan, thus creating vacuum and or venture effect pulling more FGR in (obviously the FGR is installed between these new dampers and the forced draft fan.			
Description of Installation Problems			
No real physical installation problems			
Description of Installation Solutions			
Description of Operational Problems			
1) Flame instability - "D" type, excessive vibration/ harmonics; 2) insufficient FGR creating higher NOx; 3) FD Fan capacity restriction due to throttled inlet vanes; 4) Boiler capacity limited due to fan problem; 5) Overspeeding (VFD) fan to compensate			
Description of Operational Solutions			
1) Flame stability - Mostly running by COEN for correction but addition of preformatted screen around register helped considerably; 2) insufficient FGR corrected with the addition of inlet vanes upstream of FG tie in point; 3,4,5) Not resolved			
Other Comments			
Stack monitoring O2 a must (either as alarm or BMS cut out) and recommend installing O2 monitoring in the windbox (depending on size of unit)			

Rank	First Name	Last Name	Title		
			Supervisor Planning		
Address			City	State	Postal Code
Naval Education and Training Center Public Works Engineering Division				RI	
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	20	Boiler Descriptions	HT Hot Water
Facility Name	Marine Corp Air Ground Combat Center	Boiler Serial No.	#1 14695, #2 14693, #3 14694
Boiler Type	Water Tube	Date Boiler Installed	1977
Other Type		LNB Install Date	2/1/97
Boiler Size	40 Mbtu/hr	LNB Vendor	COEN
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Blower Box Extension
Burner System	Other	NOx Emission Limit	0
Other Burner System	Coen	Flame Scanner?	Yes
No. of Burners	3	Flame Scanner Vendor	
Boiler Vendor	I.B.W.	Permit Requirements	NOx 70 ppm @ 3% O ₂ and 0.084 lbs/MBtu CO 400 ppm @ 3/6 O ₂
Description of other Modifications			
Description of Commissioning Problems			
None			
Description of Commissioning Solutions			
Description of Installation Problems			
None.			
Description of Installation Solutions			
None			
Description of Operational Problems			
Not low enough NOx			
Description of Operational Solutions			
Stack Air Recirculation			
Other Comments			
No			

Rank	First Name	Last Name	Title		
			Energy Manager		
Address		City	State	Postal Code	
Marine Corp Air Ground Combat Center		City	CA		
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	8	Boiler Descriptions	Firetube
Facility Name	Naval Medical Center San Diego	Boiler Serial No.	#1 (040903), #2 (040904), # (040905)
Boiler Type	Multiple	Date Boiler Installed	1/1/85
Other Type		LNB Install Date	2/1/97
Boiler Size	16.7	LNB Vendor	Combustion Specialties
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels	#2 Diesel Fuel as Emergency Backup	LNB Type	CS-1-17-30
Burner System	Honeywell	NOx Emission Limit	30
Other Burner System	N/A	Flame Scanner?	No
No. of Burners	3	Flame Scanner Vendor	
Boiler Vendor	Superior	Permit Requirements	NOx Limit on Natural gas 30ppm; NOx Limit on #2 Emergency Fuel 40ppm; Co. Limit 300ppm
Description of other Modifications			
Description of Commissioning Problems			
No commissioning here at the Hospital, the Damper controls were bad, and the contractor just ignored the problem.			
Description of Commissioning Solutions			
We have started doing our own testing and making adjustments to the system.			
Description of Installation Problems			
Contractor went Bankrupt, this project took over 3 years to complete.			
Description of Installation Solutions			
Get rid of these fly by night Contractor's that rip off the Government on a daily basis. Hold them accountable for the work, if they fail to get the job done in a timely manner, do not pay them.			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			
The Boiler Cabinets were wired improperly from the beginning, my personnel had to rewire these cabinets for the contractor.			

Rank	First Name	Last Name	Title		
			General Foreman		
Address		City	State	Postal Code	
Naval Medical Center		San Diego	CA		
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	6	Boiler Descriptions	
Facility Name	Point Loma	Boiler Serial No.	#2 (8563-01), #3 (8563-02)
Boiler Type	Two	Date Boiler Installed	1/19/98
Other Type		LNB Install Date	01/01/98
Boiler Size	14.7	LNB Vendor	County Burner
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Johnston Burners
Burner System	Other	NOx Emission Limit	30 ppm
Other Burner System		Flame Scanner?	Yes
No. of Burners	2	Flame Scanner Vendor	Fire Eye
Boiler Vendor	Johnston	Permit Requirements	Limit Natural Gas 30 ppm CO Limit 300 ppm
Description of other Modifications			
Description of Commissioning Problems			
Description of Commissioning Solutions			
Description of Installation Problems			
This project went very smooth, no problems to report. Contractor was very professional and extremely knowledgeable			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title		
			General Foremen		
Address		City	State	Postal Code	
		San Diego	CA		
Work Phone	Ext.	Fax Number	E-Mail Address		

Facility ID	7	Boiler Descriptions	Watertube
Facility Name	Naval Amphibious Base	Boiler Serial No.	#1 (005729), #2 (005730)
Boiler Type	Multiple	Date Boiler Installed	1/1/96
Other Type		LNB Install Date	1/1/96
Boiler Size	20	LNB Vendor	Coen
Boiler Fuel	Natural Gas	Date of Major Mod	
Combination Fuels		LNB Type	Coen Micro NOx Burners
Burner System	Other	NOx Emission Limit	30 ppm
Other Burner System	N/A	Flame Scanner?	Yes
No. of Burners	2	Flame Scanner Vendor	Fire Eye
Boiler Vendor	International Boiler Works	Permit Requirements	Limit Natural Gas 30 ppm CO Limit 300 ppm
Description of other Modifications			
Description of Commissioning Problems			
Trim System did not work properly less than 3% starving the Burners. No commissioning tests. No gas meters installed per APCD rules.			
Description of Commissioning Solutions			
We have started doing all the testing and setting ourselves to ensure the quality there, and the job is done first time right.			
Description of Installation Problems			
Contractor went Bankrupt, and didn't complete the job, the Utilities department finished the job, and have brought other contractors in to help make necessary adjustments and repairs.			
Description of Installation Solutions			
Description of Operational Problems			
Description of Operational Solutions			
Other Comments			

Rank	First Name	Last Name	Title		
			General Formean		
Address		City	State	Postal Code	
		San Diego	CA		
Work Phone	Ext.	Fax Number	E-Mail Address		

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1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE September 1999		3. REPORT TYPE AND DATES COVERED Final	
4. TITLE AND SUBTITLE Survey of Department of Defense Facilities with Low NOx Burners				5. FUNDING NUMBERS 62784 AT45 UL-XC7	
6. AUTHOR(S) Peter Herz, George Powers, Douglas Uthus, Steven Aylor, Michael K. Brewer, Peter Herz, George Powers, Douglas Uthus, Steven Aylor, and Michael K. Brewer					
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army Construction Engineering Research Laboratory (CERL) P.O. Box 9005 Champaign, IL 61826-9005				8. PERFORMING ORGANIZATION REPORT NUMBER TR 99/81	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) Headquarters, U.S. Army Corps of Engineers (HQUSACE) ATTN: CEMP-ET 20 Massachusetts Ave., NW. Washington, DC 20314-1000				10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
9. SUPPLEMENTARY NOTES Copies are available from the National Technical Information Service, 5385 Port Royal Road, Springfield, VA 22161					
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.				12b. DISTRIBUTION CODE	
13. ABSTRACT (Maximum 200 words) This study conducted a survey regarding recent experience with Low NOx Burners (LNBs) at Department of Defense facilities known to be operating or installing low nitrogen oxides-emitting burners on boilers. The data collected did not conclusively show that LNBs are chronically problematic, but a majority of the LNB-equipped boilers recorded in the data base reported problems with operation, installation, or commissioning. The most frequently reported problems were the failure of the units to reduce NOx emissions to the level promised and flame instability caused by a variety of factors.					
14. SUBJECT TERMS Department of Defense air quality Low NOx Burners (LNBs)				15. NUMBER OF PAGES 56	
				16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified		18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified		19. SECURITY CLASSIFICATION OF ASTRACT Unclassified	
				20. LIMITATION OF ABSTRACT SAR	